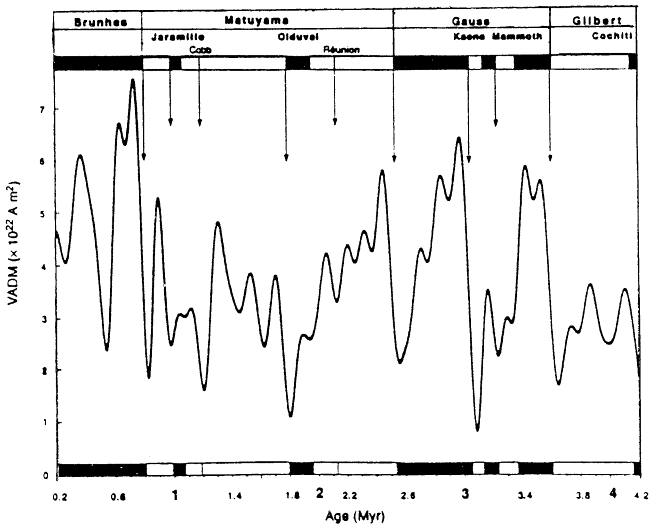
Earth's heart beats with a magnetic rhythm

Despite what you might have learned in fifth grade, compass needles don't always point north. Every several hundred thousand years, the magnetic field emanating from inside the planet does an about-face, swapping North and South Poles for reasons that geoscientists have yet to unravel.

Researchers have now discovered a clue to help explain this peculiar habit. A study of recent magnetic reversals suggests that the strength of the field follows a distinct rhythm, a phenomenon that scientists had not noticed before, report two geophysicists from the Institut de Physique du Globe in Paris. They describe their work in the Nov. 18 NATURE.



Magnetic field strength during the last 4 million years. Periods in black represent north-pointing fields; those in white, reversed fields. Field strength follows a sawtooth cycle, dropping before reversals and rising afterwards.

Valet and Meynadier/NATURE

"This is an extremely exciting result," comments Kenneth L. Verosub of the University of California, Davis. "It's tentative and a lot more work has to be done to verify it. But it could be the most fundamental insight into the behavior of the geomagnetic field that we have had since the discovery of reversals." Geoscientists first determined in the early part of this century that Earth's magnetic field flips its polarity. The last reversal occurred 750,000 years ago.

Jean-Pierre Valet and Laure Meynadier made their discovery while studying magnetic minerals within deep-sea sediments collected during a drilling expedition near the Galápagos Islands. These mineral grains recorded the direction and strength of the magnetic field at the time the sediment layers accumulated.

In the past, researchers had not succeeded in getting a continuous record of magnetic field strength going back more than a few hundred thousand years. But by combining data from several drill holes and using a new technique, Valet and Meynadier constructed a record of how the field's strength has waxed and waned over the last 4 million years, a span that encompasses 11 different reversals.

Over short periods of time, the intensity of the field continually rises and falls with no apparent cycle. But over longer periods, the record displays an overriding pattern that repeats from reversal to reversal. In general, the magnetic field peaks in strength immediately after switching polarity and then gradually weakens until it bottoms out before the next reversal. After the flip, the field quickly regains strength. The steep rise and slow decline create a pattern resembling the teeth on a saw.

Valet notes that he has found evidence confirming this pattern at four sites around the world.

The recognition of this fundamental pattern in the magnetic field should help theoreticians trying to understand reversals by steering them toward certain ideas and eliminating others. "If Valet and Meynadier are right, about 90 percent of the reversal models that have been proposed are wrong," says Peter L. Olson of Johns Hopkins University in Baltimore.

Scientists believe that the geomagnetic field arises within the liquid iron that fills Earth's outer core. As the molten metal swirls through the core, it sets up an electromagnetic dynamo that powers a magnetic field, part of which can be sensed at Earth's surface. Although they agree on this basic model, researchers have yet to uncover the details of how the field forms or why it reverses.

The new discovery suggests that the field must weaken before switching polarity — an idea that scientists had proposed previously but had found little data to support.

Before researchers embrace the new discovery, they will need to resolve several issues. Verosub wonders whether cycles of climate change have altered the record of magnetic intensity, overprinting it with a pattern that never existed. Debate will also focus on the current magnetic stage, which appears different because it has not shown the same gradual weakening in field strength.

Despite the questions, says Verosub, "This finding should stimulate a lot of new research. It's opening up a whole new dimension." *— R. Monastersky*

Electric pulses pour drugs through skin

The skin's outer surface — a layer of dead, flattened cells — provides a barrier to microbes, chemicals, and other potentially toxic agents. But at times physicians would like to breach that barrier, because administering drugs through the skin potentially offers several therapeutic advantages.

Now, researchers at the Massachusetts Institute of Technology have come up with a novel approach for temporarily increasing the permeability of skin. They administer a series of very short, up-to-100-volt pulses of electric current. The resulting rearrangement of fatty layers in the dead, outer skin appears to create temporary pores, or channels, explains Robert Langer.

Using fluorescent dyes to represent drugs, Langer's team delivered millisecond pulses of current every 5 seconds for an hour and monitored the dyes' passage through skin. Some tests used skin from human cadavers; others involved live rats. In the Nov. 15 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, Langer's group reports that the technique, electroporation, achieved a reversible, 1,000-fold increase in skin permeability.

The idea of using an electric current to pass drugs through the skin is not new. It forms the basis of iontophoresis — a process that "uses very low voltages for very long periods to drive a charged molecule [such as a drug] through a barrier," notes Langer. Electroporation, by contrast, not only employs much higher voltages for far shorter periods of time, but also works on the barrier — here, the skin — not on the drug.

Langer emphasizes that before the technique can find use in drug delivery, many nagging questions must be answered, including how safe and effective it would be for long-term use.

A lack of imaging data to confirm mechanistically what's happening to the skin surface leaves open the question of whether Langer's team achieved electroporation — at least in the classic sense — says Bruce M. Chassy. A microbiologist at the University of Illinois at Urbana-Champaign, Chassy uses electroporation to move materials into bacteria.

However, he adds, "whether it's electroporation is not really important" — as long as the technique delivers a drug without permanently damaging the skin. Indeed, he described the new MIT results as "exciting." In fact, he said, it may possess as much potential to transport samples out of the body — perhaps for noninvasive blood sampling — as it has to move small samples inside. *— J. Raloff*